

REMARKS

Applicants have amended the first page of the specification to add a prior application being relied upon under 35 USC §120, consistent with the requirements of 35 USC §120. It is respectfully submitted that this amendment to the specification does not add new matter to the application.

Applicants have amended their claims in order to further clarify the definition of various aspects of the present invention. Specifically, each of claims 8 and 27, the sole remaining independent claims in the application, has been amended to recite that the semiconductor sample has an Al alloy film on a substrate, and a refractory metal film directly laminated on the Al alloy film. Claim 27 has been further amended to recite that the resist mask is formed on the refractory metal film. Each of claims 8 and 27 has been further amended to recite, in a "whereby" clause, that corrosion could be generated and accelerated by electrolytic corrosion due to battery action between refractory metal film and the Al alloy film; and the remainder of claims 8 and 27 have been amended to recite that the structure etched is the refractory metal film directly laminated on the Al alloy film, and the Al alloy film. Note, for example, the paragraph bridging pages 2 and 3 of Applicants' specification. See also, for example, the Examples beginning on page 48 of Applicants' specification.

The obviousness-type double patenting rejections set forth in Items 7 and 8 on pages 10 and 11 of the Office Action mailed August 29, 2003, are noted. Submitted concurrently herewith is a Terminal Disclaimer in the above-identified application, with respect to each of U.S. Patent No. 5,007,981 and U.S. Patent No. 6,077,788. In view of the present filing of this Terminal Disclaimer, and noting indications by the Examiner in Item 6 on page 10 of the Office Action mailed

August 29, 2003, the obviousness-type double patenting rejections are clearly moot.

The enclosed Terminal Disclaimer is being submitted to facilitate proceedings in connection with the above-identified application, so as to simplify remaining issues. It is respectfully submitted that the present filing of this Terminal Disclaimer does not constitute agreement with, or an admission as to the propriety of, the obviousness-type double patenting rejections; and does not constitute agreement with, or an admission as to the propriety of, arguments made by the Examiner in connection with the obviousness-type double patenting rejections.

Applicants respectfully submit that all of the claims presented for consideration by the Examiner patentably distinguish over the teachings of the references applied by the Examiner in rejecting claims in the Office Action mailed August 29, 2003, that is, the teachings of the U.S. patents to Peterman, et al., No. 4,855,252, to Moe, et al., No. 4,722,355, to Noguchi, et al., No. 4,487,678, and to Boswell, No. 4,810,935, European Patent Application No. 247 603 (Nakamura), and the pertinent pages of the publication by Elliott, Integrated Circuit Fabrication Technology (1992), pages 56-59, 256, 257, 268, 269 and 272-275, under the provisions of 35 USC §103.

For purposes of clarification, it is noted that the listed rejections in the Office Action mailed August 29, 2003 include a rejection in Item 3 on page 2 of this Office Action mailed August 29, 2003, and a rejection under Item 5 on page 9 of the Office Action mailed August 29, 2003. There does not appear to be any Item 4 in this Office Action mailed August 29, 2003. In any event, with respect to the rejections in Items 3 and 5, the additional reference of Noguchi, et al. is applied in Item 5, as compared with references applied in Item 3.

It is respectfully submitted that these references as applied by the Examiner would have neither taught nor would have suggested such a method of processing a semiconductor sample as in the present claims, the sample having an Al alloy film on a substrate and a refractory metal film directly laminated on the Al alloy film, whereby electrolytic corrosion can be generated and accelerated due to battery action between these two films, this process including specified steps of etching the two films through a resist mask, by means of a first plasma while applying radio-frequency bias power to the sample, residual corrosive compounds being left on the sample after etching; and after this step of etching, treating the etched sample by means of a second plasma to remove at least the resist mask and residual corrosive compounds formed in the etching, with this second plasma treatment (ashing treatment) being carried out at a second location different from the first location where the etching is carried out, the laminate being transferred between the two locations through a chamber having a pressure reduced from atmospheric pressure; and thereafter contacting a surface of the two films with at least one liquid, to remove residual corrosive compounds not removed during the second plasma treatment; and then drying the surface of the two films, with these processing steps being performed in a single sample processing apparatus. Note claim 8; see also claim 27.

Moreover, it is respectfully submitted that the teachings of these applied references would not have disclosed, nor would have suggested, such a method of processing a semiconductor sample as discussed previously, including removing the corrosive compounds, and wherein the residual corrosive compounds left on the etched sample, after the etching, includes residual corrosive compounds left in material of the resist mask remaining on the etched surface of the refractory metal

film and the Al alloy film, with these residual corrosive compounds being removed during contact with the liquid (as set forth in claims 8 and 27). See claims 67 and 68.

In addition, it is respectfully submitted that the teachings of these applied references would have neither disclosed nor would have suggested such a method of processing a semiconductor sample, having features as discussed previously, and further including (but not limited to) wherein the atmospheres in which the various steps take place are those set forth in claims 9 and 12-14; and/or wherein the drying uses an inert gas or introduces a dry gas to the sample (see claims 10 and 15); and/or wherein the ashing/treating using the second plasma is performed using oxygen in the second gas in which the second plasma is formed (see claim 11); and/or wherein in the ashing step (treatment by the second plasma) the whole of the resist mask is removed (see claim 17).

The present invention is directed to a method of processing (which includes an etching step) a semiconductor sample having an Al alloy film on a substrate and a refractory metal film laminated directly on the Al alloy film, which are films of materials of different ionization tendencies, e.g., to pattern the laminate, using a resist mask during the etching for patterning both of the two films. This structure of the refractory metal film directly laminated on the Al alloy film is especially open to corrosion due to battery action between these two films of different materials of an Al alloy film and a refractory metal film. In particular, the present invention is directed to such method, wherein corrosion, including electrolytic corrosion, of the etched layers of the refractory metal film and the Al alloy film, can be avoided. The present invention is particularly suitable for processing a semiconductor sample in the manufacture of semiconductor devices, which processing utilizes a resist mask

during the etching, in forming a pattern from the Al alloy film and the refractory metal film directly laminated thereon, overlying a semiconductor substrate.

During such processing, the resist mask can act not only to provide selective etching of the laminate, but also forms a protective film on sidewalls of the etched Al alloy film and the refractory metal film directly laminated thereon while the etching is performed. During etching, where the films include films of the refractory metal film directly laminated on the aluminum alloy film, the etching speeds are different and a notch or undercut would occur at the aluminum alloy film, which has a higher etching speed than the refractory metal film. However, when using a resist, and where a radio-frequency bias power is applied during the etching, carbon and hydrogen of the resist are sputtered during the etching and adhere to the sidewalls of the etched refractory metal and aluminum alloy, for example, thereby providing a protective film on the sidewalls, preventing the notch or undercut. This protective film, made of components of the resist film, is removed during removal of the resist. However, during formation of this protective film, residual corrosive components (for example, chlorides of aluminum, titanium, etc.) are incorporated in the protective film, which is especially detrimental in connection with electrolytic corrosion (discussed further infra).

A corrosion-proofing technique after etching is disclosed, for example, in U.S. Patent No. 4,487,678. This technique subjects a resist film, after plasma etching a layer using the resist as a mask, to removal in a second plasma processing chamber, connected to the etching chamber. The second plasma treatment not only removes the resist film, but also removes chlorine compounds which are corrosive components remaining in the resist films or on the etched surface.

It is also known to heat the sample, after etching, to at least 200°C, in order to promote evaporation of chlorides that are residual corrosive compounds, for avoiding corrosion.

However, Applicants have found that the above-described corrosion-proofing techniques after etching in a plasma are not sufficient for samples having an aluminum alloy film and a refractory metal film directly laminated thereon, overlying a substrate, where a resist mask is provided over the laminate of the two films during the etching. That is, the previously proposed corrosion-proofing techniques fail to provide sufficient corrosion-proofing effect after etching a sample having a structure including an aluminum alloy film and a refractory metal film laminated directly on the aluminum alloy film, which are films of materials of different ionization tendencies. See, for example, page 2, lines 11-18, of Applicants' specification. This insufficiency is particularly a problem at present, in view of the materials utilized as a wiring film in integrated circuit devices, and also in view of the increased density (decreased size, including decreased size of the wiring) of integrated circuit devices. As described in the paragraph bridging pages 2 and 3 of Applicants' specification, even if corrosive materials generated by etching are removed by utilizing a plasma at a high temperature of 200°C, corrosion occurs due to the effect of moisture on remaining corrosive compounds, within some minutes or several hours after the sample is withdrawn into the atmosphere.

That is, Applicants have found that in etching the specific structure of the recited materials as in all of the present claims, using a resist mask, as in the presently claimed invention, a protective film (discussed previously) is formed on sidewalls of the etched laminate structure, and residual corrosive compounds remain

in this protective film. This protective film is made of components of the resist; and by carrying out plasma processing for resist removal, residual corrosive compounds in the protective film are exposed to the etched surface, and residual corrosive compounds not removed in the plasma processing for resist removal can cause corrosion of the etched structure.

In addition, a further corrosion problem has been uncovered by Applicants, and arises in connection with treatment of samples having structure of films of the recited materials as in the present claims (that is, the refractory metal film directly laminated on the Al alloy film), which have different ionization tendencies. Since the material to be subjected to the etching is a laminate structure, the material is subjected to quick corrosion by an electrolytic corrosion between the adjacent films due to a battery action developing therebetween by the different materials having different ionization tendencies. Particularly where laminated structure, of the recited materials as in the present claims, is processed by etching using a resist, prior corrosion-proofing techniques have failed to provide sufficient corrosion-proofing effect, due to the quick and relatively large amount of electrolytic corrosion.

Against this background, Applicants provide a process which is adequate for corrosion proofing even of the structure including the aluminum alloy film having the refractory metal film directly laminated thereon, after etching such structure using radio-frequency bias potential, and even where a resist mask is used. Moreover, the present process can effectively be used to both provide corrosion resistance and remove a resist film used, for example, for patterning the structure of the Al alloy film having the refractory metal film directly laminated thereon, overlying the substrate. Applicants have found that by utilizing, in combination after the plasma etch, a

treatment in a second plasma both to remove the resist mask and remove residual corrosive compounds formed in the plasma etching, with the semiconductor sample being transferred from the etching location to the treatment in the second plasma through a chamber forming an atmosphere having an pressure reduced from atmospheric pressure, and then contacting the sample with a liquid (for example, water), with all processing from etching to drying being performed in a single sample processing apparatus, the objectives according to the present invention are achieved; and, in particular, the structure of the laminate films specified materials can be etched using radio-frequency bias potential and a resist, e.g., as a mask, without corrosion of the films of the structure, using a relatively simple apparatus.

It is emphasized that the problem of corrosion is much greater when processing a semiconductor sample having an aluminum alloy film and a refractory material film directly laminated on the Al alloy film (which have different ionization tendencies), due to, for example, the corrosion generated and accelerated by battery action between the films. Notwithstanding this greater problem, which greater problem is unexpected from the applied references, the corrosion problem is unexpectedly avoided, and sufficient corrosion protection can be achieved, by processing according to the present invention. As to unexpectedly better results achieved according to the present invention, note the paragraph bridging pages 7 and 8 of Applicants' specification. Note also, for example, the Example on pages 48-51 of Applicants' specification, particularly Fig. 8 and the description in connection therewith on pages 50 and 51 of Applicants' specification. In connection with Fig. 8 and especially "A", "B", "C" and "D" shown along the ordinate, see the paragraph bridging pages 48 and 49 of Applicants' specification. It is respectfully submitted that

this evidence in Applicants' specification shows unexpectedly better results in solving an unexpectedly severe problem, and further establishes unobviousness of the present invention. See In re DeBlauwe, 222 USPQ 191(CAFC 1991).

Elliott discloses various photo-fabrication processes for aluminum etching. This publication discloses a specific procedure including a CF_4 plasma to preclean a wafer and harden the resist; a CCl_4 plasma for aluminum etching; an H_2 plasma to remove chlorides from the parts and the chambers; and a $\text{CF}_4\text{:O}_2$ plasma to remove residual silicon precipitates. This publication then goes on to state that, after etching, occasionally a residue is left on the wafer, confirmed to be Al_2O_3 and SiO_2 , and that this residue can be removed by partial dry etching followed by immersing in a wet-aluminum etch. Also described in this publication is that, after aluminum etching with positive photoresist, wafers should be stripped as soon as possible, because some free radicals may be absorbed and this will form hydrochloric acid which will attack the aluminum.

As can be seen in the foregoing, Elliott is concerned with etching aluminum; moreover, this publication refers to an inorganic residue. It is respectfully submitted that the pertinent pages of this publication, as applied by the Examiner, would not have taught, nor would have suggested, etching of an aluminum alloy film and a refractory metal film directly laminated on the Al alloy film, whereby corrosion could be generated and accelerated by electrolytic corrosion due to battery action between these films, as presently claimed. More particularly, it is respectfully submitted that Elliott would not have taught, nor would have suggested, the particularly severe corrosion problem arising in connection with plasma etching the aluminum alloy film and the refractory metal directly laminated thereon, particularly where the etching is

performed using a resist, or the solution to this problem as achieved by Applicants. Especially since Elliott discloses an inorganic residue, this reference would not have taught or suggested the more severe corrosion problem arising when using a resist as in the present claims.

In particular, it is respectfully submitted that, in Elliott, there is no disclosure, nor any suggestion, of an electrolytic corrosion problem arising in connection with etching of the aluminum alloy film and the refractory metal film directly laminated on the Al alloy film, particularly when a resist mask is used, as in the present claims, or the means for solving this problem as achieved according to the present invention and discussed previously.

Moreover, it is respectfully submitted that Elliott does not disclose, nor would have suggested, treatment of the structure of the aluminum alloy film and refractory metal film directly laminated thereon, or treatment of such structure with a resist thereon, or wherein the etching is performed while applying radio-frequency bias power to the sample, much less the more severe corrosion problems arising in such processing. Not having even disclosed the problem, it is respectfully submitted that Elliott, either alone or in combination with the teachings of the other applied references discussed infra, would not have taught or suggested the processing according to the present invention, including additionally processing in the single sample processing apparatus, which avoids the severe problem of corrosion.

According to the present invention, during etching of the Al alloy film and refractory metal film directly laminated on the Al alloy film, radio-frequency bias power is applied. Accordingly, when ions in the plasma during etching are incident to the sample, the resist mask is sputtered, and further the sputtered resist

components adhere to the sidewall of the etching portion to form the protection film.
At this time, the chlorine system reaction compounds adhere to the sidewall of the
etching portion together with the resist components. The chlorine system reaction
compounds, e.g., enter into the sidewall protection film and become residual
corrosion compounds, which are difficult to remove. Thus, the circumstances in
general around which severe corrosion problems arise, according to the present
invention, are defined in the claims as presently amended; and it is respectfully
submitted that the references as applied by the Examiner do not disclose, nor would
have suggested, the more severe corrosion problems arising in processing as in the
present claims, or avoiding such problems by the processing of the present
invention, as discussed previously. In this regard, note that using the single sample
processing apparatus for all steps from etching to drying, and including (1) the
second plasma treatment to remove resist, and (2) the washing to remove remaining
residual corrosive components, corrosion is prevented even in light of the more
severe environment, in a process which is simple and uses relatively simple
apparatus.

It is respectfully submitted that the secondary references as applied by the
Examiner, either with or without the teachings of U.S. Patent No. 4,487,678 to
Noguchi, et al., would not have rectified the deficiencies of Elliott, such that the
presently claimed invention as a whole would have been obvious to one of ordinary
skill in the art.

Nakamura discloses a method for stripping a photoresist coated on a layer of
an aluminum alloy, formed on a semiconductor substrate. This patent document
discloses that such stripping causes corrosion of the aluminum alloy, and describes

various known procedures which attempted to prevent this corrosion but which are not successful when an aluminum alloy is etched. This patent document then goes on to describe a method for etching an aluminum alloy, which avoids the corrosion problem of the aluminum alloy. See, for example, page 3, lines 1-10 of Nakamura. Note also page 3, lines 42-46 of Nakamura, describing transfer of the substrate to a dry processing apparatus (for stripping the patterned photoresist) from the etching apparatus, through a vacuum system or an inert gas purged system to avoid exposure to the atmosphere, avoiding corrosion of the aluminum alloy.

It is emphasized that Nakamura discloses a technique for etching an aluminum alloy. It is respectfully submitted that the teachings of this reference, either alone or in combination with the teachings of Elliott, would have neither taught nor would have suggested the method of etching the aluminum alloy film and refractory metal film directly laminated thereon, especially wherein the structure processed has a resist thereon, or the other aspects of the present invention as discussed previously, including transfer between the first and second locations through the recited chamber, or use of the single sample processing apparatus, for example. Again, it is emphasized that the combined teachings of these references would have neither disclosed nor would have suggested the particularly acute corrosion problem arising when etching an aluminum alloy film and a refractory metal film directly laminated on the aluminum alloy film, especially when the laminate of the two films has a resist film thereon, and more especially where a radio-frequency bias power is applied during etching, and a solution to this problem as achieved by the present invention.

Moe, et al. discloses a method for stripping photoresist from wafers, wherein the wafers are individually fed through a machine and are first soaked in stripping solution and then subjected to high pressure, high volume flow of stripping solution over the wafers in a closed environment. The wafers then pass into another housing and are rinsed with alcohol or water and then are passed to another housing where they are dried with heated air or nitrogen. See column 1, lines 28-35.

Initially, it is respectfully submitted that the teachings of Moe, et al., as applied by the Examiner, are not properly combinable with the teachings of Elliott and of Nakamura. In this regard, it is emphasized that Moe, et al. is concerned with a liquid method for stripping photoresist from wafers. The liquid which is the stripping solution is rinsed off. It is respectfully submitted that one of ordinary skill in the art concerned with dry etching and ashing using a plasma, would not have looked to the teachings of Moe, et al. In this regard, it is respectfully submitted that Moe, et al. is directed to a different technology (liquid stripping, as compared with dry ashing) and is concerned with a different problem (effective stripping using a liquid, in Moe, et al., as compared to dry etching and dry ashing procedures in Elliott, as applied by the Examiner, and in Nakamura). In view of these differences in technology and problems addressed, it is respectfully submitted that Moe, et al. is not analogous art in connection with the other applied references; such that one of ordinary skill in the art concerned with in either of Elliott or Nakamura would not have looked to the teachings of Moe, et al.

In addition, it is respectfully submitted that the Examiner has pointed to no proper motivation for combining the teachings of Moe, et al. with the teachings of the other applied references.

Even assuming, arguendo, that the teachings of Moe, et al. were properly combinable with the teachings of Elliott and Nakamura, the combined teachings would have neither disclosed nor would have suggested the etching of the aluminum alloy film and the refractory metal film directly laminated on the aluminum alloy film, much less having the resist on the refractory metal film, or wherein the etching is performed with radio-frequency bias applied, or specific problems arising in connection therewith, which are avoided by the present invention, as discussed previously.

Peterman, et al. discloses a process for making metal contacts self-aligned to interconnecting metallurgy, the process including depositing a layer of polyimide over an insulating layer; depositing a layer of photoresist over the polyimide layer; photolithographically defining a wiring pattern in the layer of photoresist and transferring that pattern into the polyimide layer; depositing a second layer of photoresist; lithographically defining a pattern of contacts in the layer of resist and transferring that pattern into the insulating layer; and depositing a layer of metal which forms the contact studs and interconnect wiring. See column 1, line 56 to column 2, line 2. This patent discloses that the layer of metallurgy is "conformally deposited", the metal layer being blanket etched to the surface of the polyimide layer in a reactive ion etcher. See column 3, lines 46-60. This patent further discloses that the interconnection metallurgy can be any material conventionally used for such purposes, including, but not limited to, aluminum, polysilicon, copper, silicon, titanium, tungsten, silver, gold or alloys or composites thereof. See column 3, lines 47-52.

It is respectfully submitted that Peterman, et al. discloses, e.g., a blanket etch of the interconnection wire. It is respectfully submitted that Peterman, et al., either alone or in combination with the teachings of the other references as applied by the Examiner, would have neither taught nor would have suggested the severe corrosion problems arising when etching of an aluminum alloy film and a refractory metal film directly laminated thereon, as discussed previously. In addition, the blanket etch of Peterman, et al. would have taught away from use of the resist, and application of radio-frequency bias power, as in the present invention, and corrosion problems arising, and wherein severe corrosion problems arise due to electrolytic corrosion, as discussed supra.

Moreover, it is respectfully submitted that Peterman, et al., either alone or in combination with the teachings of the other applied references, would have neither taught nor would have suggested the particularly acute problem of corrosion arising when etching the films of the specified materials, with the refractory metal film directly laminated on the Al alloy film, which problem is even more severe in processing utilizing a resist and with application of radio-frequency bias power; or avoidance of such corrosion through use of the present method, as discussed previously.

Moreover, it is again emphasized that Peterman, et al. discloses a conformal deposition with blanket etch. It is respectfully submitted that the teachings of this reference, even in combination with the teachings of the other references as applied by the Examiner, would have taught away from etching the films as in the present claims, using a resist mask.

It is also emphasized that the present claims recite that the structure etched is the refractory metal film directly laminated on the Al alloy film, and the Al alloy film. It is respectfully submitted that the disclosure of Peterman, et al., either alone or in combination with the teachings of the other references, would have neither taught nor would have suggested etching of the specific structure of the specific materials recited in the present claims, and more severe corrosion problems arising in connection therewith, as discussed previously; or avoidance of such problems as achieved according to the present invention.

The newly cited patent to Boswell discloses structure for generation of large volume plasmas in insulating cavities, for use in dry etching applications. This patent discloses establishing the plasma in a cavity which is connected to an adjoining auxiliary region, at the same internal pressure as the cavity, into which the plasma extends. Note especially column 2, lines 3-11. Note also column 2, lines 12-21. This patent also discloses use of resonance conditions resulting in the production of a high volume of atomic gas species. Note especially column 2, lines 56-62. Note also column 3, lines 1-35 and 36-66, respectively disclosing apparatus for producing a plasma and a method of producing a magnetoplasma. Note also column 5, lines 57-66, disclosing that the etching angle of the material being etched can be varied by applying an appropriate rf voltage and frequency to bias the substrate of the material; and column 6, lines 3-12, disclosing various gases which can be used for forming the plasma.

Even assuming, arguendo, that the teachings of Boswell were properly combinable with the teachings of the other references applied by the Examiner, it is respectfully submitted that these combined teachings would have neither disclosed

nor would have suggested etching of the specific films, having a resist thereon, as in the present claims, including the severe corrosion problems arising in connection therewith; and avoidance of such problems as achieved by the present invention utilizing each of the processing steps after the etching as in the present claims, and using a single sample processing apparatus.

Noguchi discloses dry-etching apparatus which can etch aluminum wiring films on wafers of integrated circuit elements, and can provide a post-treatment in which etching resist films are removed, together with the chlorides deposited on the surface of the wafers during the etching process. The described apparatus provides a structure which can supply dry-etched wafers to a post-treatment stage without removing them into the atmosphere. See column 2, lines 3-6. The structure includes a vacuum antechamber attached to the etching chamber, so that the wafers recovered from the etching chamber can be removed into the atmosphere via the post-treatment chamber. In a specific embodiment shown in Figs. 1-4, this patent discloses dry-etching apparatus provided with a wafer-feed means 1, a first vacuum antechamber 2 which receives a wafer from the feed means 1 and places the wafer in a vacuum atmosphere, an etching chamber 3 which receives the wafer from the first vacuum antechamber and etches it, a second vacuum antechamber 4 which takes the etched wafer from the etching chamber 3 and holds it therein, a post-treatment chamber 5 formed in a lower portion of the second vacuum antechamber 4 which removes chlorides deposited on the surface of the etched wafer, as well as the etching resist film, and a recovery means 6 positioned opposite the second antechamber which receives the post-treated wafer discharged from the second vacuum antechamber 4. See column 2, lines 28-43.

Even assuming, arguendo, that the teachings of Noguchi, et al. were properly combinable with the teachings of the other references as applied by the Examiner, such combined teachings would have neither disclosed nor would have suggested the presently claimed subject matter, having all the features as discussed previously, including etching of the aluminum alloy film and the refractory metal film directly laminated thereover, with etching being performed using a resist and with radio-frequency bias power applied, and the especially severe corrosion problem arising in connection therewith; and avoiding such problem by the processing including the second plasma treatment (ashing treatment) at a second location apart from the etching location, with the sample having the laminate being transferred from the first location of the etching to the second plasma treatment location through a chamber forming an atmosphere having a pressure reduced from atmospheric pressure, the processing further including the liquid contact and drying, with all of the etching, treatment with the second plasma, liquid contact and drying being performed in a single sample processing apparatus, thereby avoiding the especially severe corrosion problem, as discussed previously.

The contention by the Examiner in the paragraph bridging pages 4 and 5 of the Office Action mailed August 29, 2003, with respect to combinability of the teachings of the applied references is noted. In view of the especially severe corrosion problem arising in connection with etching an aluminum alloy film and a refractory metal film directly laminated thereover, when processing using a resist during the etching and applying radio-frequency bias power during the etching, wherein, inter alia, quick and severe corrosion problems arise due to, for example,

battery action, it is respectfully submitted that there would not have been such a reasonable expectation of success as alleged by the Examiner.

The contention by the Examiner on page 5 of the Office Action mailed August 29, 2003, that "mere addition of a resist film can only have the obvious result of preventing etching of the covered areas", is respectfully traversed. To the contrary, as disclosed by Applicants in their specification and as set forth in the present claims, a more severe corrosion problem occurs when etching using a resist mask, due to residual corrosive components existing in a protective film of material of the resist mask on side surfaces of the etched structure. Clearly, use of the resist mask has an "unobvious" result of increasing the corrosion problem, as discussed previously.

Reference by the Examiner to the Decision by the Board in the parent application is noted. It is respectfully submitted that the claims in the present application are clearly different from the claims considered by the Board; and while, of course, the Decision by the Board is to be considered, it is respectfully submitted that this Decision is not controlling with respect to the present claims, having many additional features and aspects of the present invention not in the claims considered by the Board.

The contention by the Examiner in the paragraph bridging pages 6 and 7 of the Office Action mailed August 29, 2003, that "on page 8 of the response", Applicants' representative "misses the mark" in describing the source of the corrosive material, is respectfully traversed. Initially, page 8 of the Amendment After Final Rejection filed April 28, 2003 contains no allegations concerning source of the corrosive materials. In any event, Applicants have noted that during formation of the

protective film (this protective film being formed on the sidewalls of the laminate structure while the etching progresses), corrosive materials are incorporated. This does not indicate that the source of the materials is produced during resist formation, but rather sets forth that the corrosive materials arise during etching and are incorporated into material of the resist when the material of the resist forms the protective film on side surfaces (exposed during the etching) of the laminate structure etched, during the etch process.

Applicants respectfully traverse the conclusion by the Examiner that the prior art of Elliott would have appreciated the incorporation of the corrosive materials into the material of the resist when forming a protective film along the sidewalls of the laminate. That is, it is again emphasized that Elliott discloses a blanket etch, not a patterned etch. It is not seen how, with such disclosure of a blanket etch, Elliott could have described corrosive compounds being incorporated in the protective film along the sidewalls of the etched structure, causing the electrolytic battery corrosion discussed previously. Again, it is respectfully submitted that neither Elliott nor any of the other applied references would have disclosed or would have suggested the problem addressed by the present invention, source of such problem and solution thereto as achieved according to the present invention. Taking the present invention as a whole, including the problem addressed and source thereof, and solution thereto, it is respectfully submitted that the present invention patentably distinguishes over the teachings of the applied references.

The contention by the Examiner in the middle of page 7 of the Office Action mailed August 29, 2003, that Al and Al alloys are embraced by the claims, the Examiner referring to claim 66, is not understood. Clearly, claim 66 has previously

been cancelled (see the Amendment After Final Rejection filed April 28, 2003); and, in any event, note that claim 66 was dependent on claim 27, which (at that time) recited a method of processing a semiconductor sample having a laminate of at least two adjacent layers. It is respectfully submitted that, previously, "Al" and "alloys of ... Al", in claim 66, materials used in the laminate; but, in any event, claim 66, dependent on claim 27, as a whole required processing of a laminate.

The contention by the Examiner in the last four lines on page 7 of the Office Action mailed August 29, 2003, is noted. Even if each of various treatments after etching would have been known, it is respectfully submitted that Applicants have found a combination of treatments, after etching, which avoids corrosion where the etching is performed of a specified structure, including a resist. This is recited in the present claims. It is respectfully submitted that the teachings of the applied references do not disclose, nor would have suggested, processing of the structure recited in the present claims, including the more severe corrosion problems in connection therewith; and avoiding such problems by the plurality of treatments as in the present claims, after the etching.

The contention by the Examiner on page 8 of the Office Action mailed August 29, 2003, that the claims "differ slightly from those reviewed by the board of appeals in the parent application, 08/470443", is respectfully traversed. A review of the claims on appeal and in the present application show clear and extensive differences including (for example, with respect to independent claims) materials etched and many other differences such as use of a single sample processing apparatus and application of radio-frequency bias power, among others.

The contention by the Examiner that arguments-by Applicants that the specification provides data concerning unexpected results, are unsupported, set forth in the middle of page 8 of the Office Action mailed August 29, 2003, is respectfully traversed. In this regard, the Examiner's attention is respectfully directed to Fig. 8 and the description in connection therewith on pages 50 and 51 of Applicants' specification. Note also the paragraph bridging pages 48 and 49 of Applicants' specification, describing what is meant by "A", "B", "C" and "D", along the ordinate in Fig. 8. Clearly, Fig. 8 must be considered as evidence of unexpected results, in connection with the present invention. See In re Deblauwe, 222 USPQ 191 (CAFC 1984). It is respectfully submitted that the data shown in Fig. 8 shows unexpectedly better results in time till corrosion, for processing according to the present invention, including the ashing and wet and dry processing, as compared to the time till corrosion wherein only the plasma post-processing, or only wet and dry-processing, are performed.

The additional comment by the Examiner in the middle of page 8 of the Office Action mailed August 29, 2003, that the specification on page 50, at lines 9-13, "clearly [indicates] that laminate and alloy (single layer) wiring both suffer from the same problems", is noted. In regard thereto, the Examiner's attention is respectfully directed to the paragraph bridging pages 50 and 51 of Applicants' specification, which discloses as follows:

"As can be seen from Fig. 8, in the case of wiring materials such as the laminate layer wiring in which corrosion is vigorous, the plasma post-processing such as resist ashing after etching, or water washing processing and drying processing after etching without carrying out plasma post-processing, cannot provide a sufficient corrosion-proofing effect. A high corrosion-proofing effect for more than 30 hours can only be obtained by carrying out in series the etch-processing, the plasma post-

processing such as ashing of the resist, the water washing processing and the dry-processing."

It is respectfully submitted that Applicants' disclosure as a whole clearly shows unexpectedly greater problems arising where materials of different ionization potential are provided adjacent to each other; and that even with such materials, sufficient avoidance of corrosion is achieved according to the present invention, utilizing the series of processing treatments after etching.

The contention by the Examiner in the last seven lines on page 8, and the first five lines on page 9, of the Office Action mailed August 29, 2003, with respect to how the resist functions, is noted. It is respectfully submitted that this interpretation by the Examiner of the functioning of the resist shows that the Examiner does not appreciate the problem arising in connection with the present invention. That is, it is acknowledged that the resist is initially applied on the surface of the material being etched, with openings therethrough so as to etch material to be etched. During the etching, it is respectfully submitted that portions of the resist are etched and are deposited (e.g., as resist residues) on exposed edges (side surfaces) of the materials being etched. It is this deposited resist (resist residue) that includes corrosive materials, and has been discussed in the foregoing. While this resist material deposited during the etching on the exposed side edges acts as a protective layer to prevent undercutting, problems arise in connection therewith as discussed in the foregoing. Clearly, as would be appreciated by one of ordinary skill in the art, the resist, during etching, forms a protective layer on side edges of the etched film, exposed during etching, with corrosive materials included in this deposited resist residue, causing problems as discussed in the foregoing.

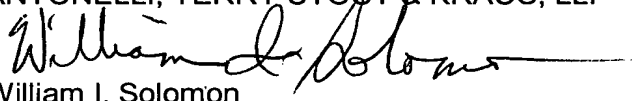
That is, the "protective layer" is the resist residue-deposited on side edges of the film exposed by etching, and is not the original resist on the upper surface of the films being etched, for providing overall patterning.

In view of the foregoing comments and amendments, reconsideration and allowance of all claims remaining in the application, are respectfully requested.

To the extent necessary, Applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to the Deposit Account No. 01-2135 (Case No. 503.28546CC9), and please credit any excess fees to such Deposit Account.

Respectfully submitted,

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